Coupled reactions

Experiment No. 2: Coupled Reactions Hibeejeebee Institute of Chemistry, University of the Philippines, Diliman, Quezon City 1101 Philippines Results and Discussions In this experiment, two setups involving magnesium pieces were executed in succession; the first one had ignited pieces of magnesium left burning between two slabs of dry ice with vent holes; the second involved lighting up magnesium strips openly in the air. The following table summarizes the observations obtained from both setups: Table 1.

Observations from the two setups SetupObservations 1The slabs of ice lit up while the magnesium strips burned between them. Inspecting the setup after the strips ceased ignition, black and white materials were formed in the location where the Mg strips were burned. 2The magnesium strips turned white when the setup ceased burning. In Setup 1, the formation of matter after the experiment can be explained by the following exothermic reaction: $Mg(s) + CO_2(s)\ MgO(s) + C(s)$ [1]

Here, the black matter that formed was the solid carbon, while the white one being the magnesium oxide. The reaction that follows summarizes what happened in Setup 2: $Mg(s) + O_2(s)\ MgO(s)$ [2] The white product that was observed is magnesium oxide. There are three ways to obtain a product from a nonspontaneous reaction: (1) Changing reaction conditions to make the given reaction spontaneous and (2) through electrolysis. The third is exhibited by this experiment: by " coupling" two reactions.

A coupled reaction is a system wherein a nonspontaneous reaction is combined with a spontaneous one in order to obtain a product from the latter process. The nonspontaneous process in the experiment is the breakdown of CO_2 to oxygen gas and solid carbon. By adding up the ? G° values of both reactions, a negative value will result, indicating a spontaneous reaction. ? G° for MgO(s) : -569. 4 kJ mol-1 ? G° for CO_2(s) : -394. 4 kJ mol-1 Mg(s) + O_2(s) 2MgO(s) ? G° = 2(-569. 4) CO_2(s) O_2(g) + C(s) ?

G° = 394. 4 [3] Mg(s) + CO_2(s) 2MgO(s) + C(s) ? G°rxn = -744. 4 kJ mol-1 The negative theoretical ? G° value indicates a spontaneous reaction for its formation. It is shown that the result gives a negative value, thus, the net reaction is said to be a spontaneous process. This process also exhibits the reducing property of magnesium, as it is oxidized while losing electrons in the process. In addition, the experiment presents the impracticality of using CO_2 to extinguish magnesium fires, as it will only worsen the situation.

Answers to Questions 1. Why does it take a long time to light the Mg ribbons? Magnesium readily reacts with the oxygen in the air upon exposure, thus, forming a magnesium oxide layer on the surface, covering the pure Mg metal. Due to this, O_2 in the surroundings won’t be readily available for burning, thus, the difficulty of lighting the metal. 2. Why is it important to immediately cover the Mg ribbon with the other slab of dry ice once it starts burning?